Hierarchical Pattern Mapping

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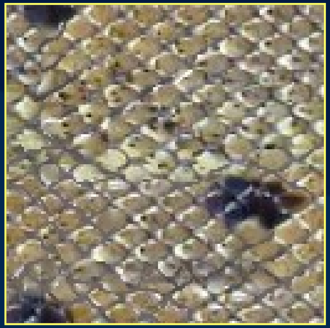
Motivation

- Seamlessly texture a mesh using a texture sample



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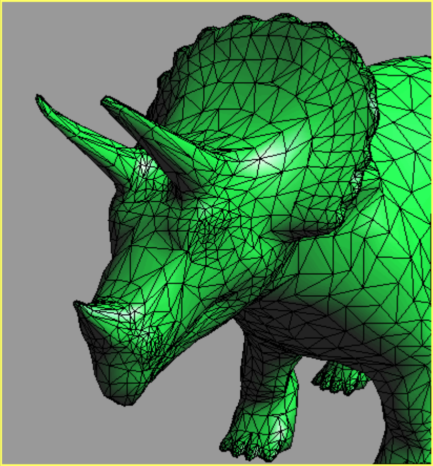

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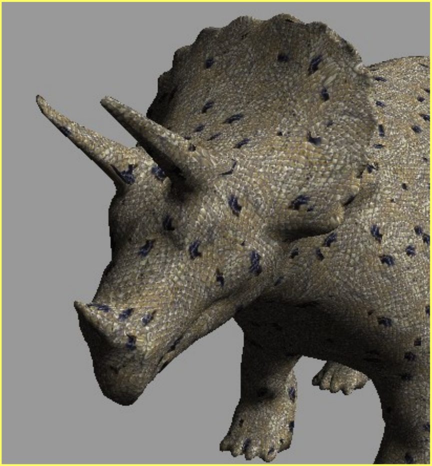
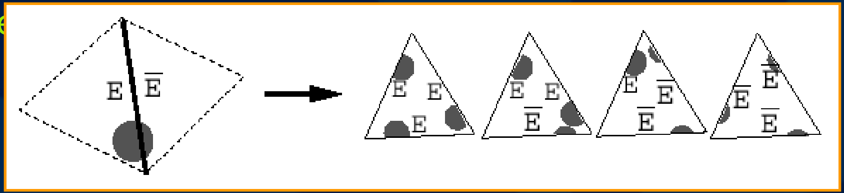
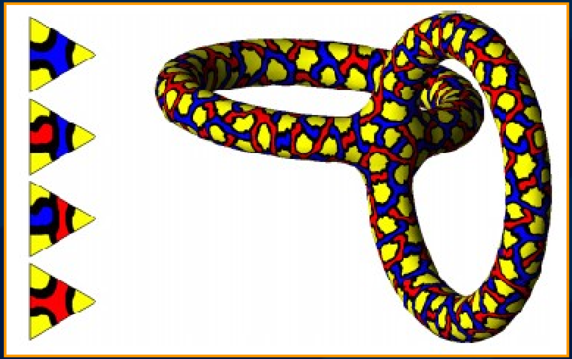


- Difficult because
  - Generally no continuous parameterization of the mesh
  - It's hard to texture locally without deformations
  - Very few information in the input sample

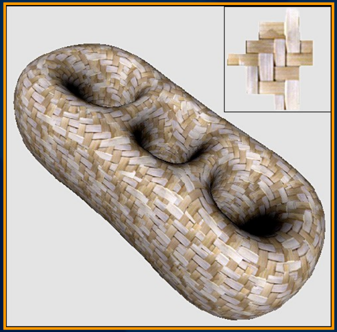
Previous works - Pattern mapping

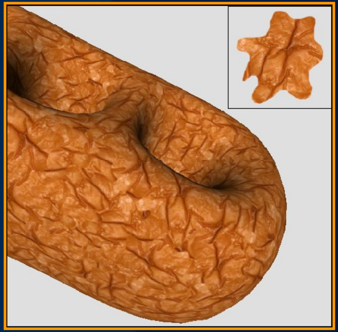
- Pattern-based texturing [Neyret & Cani '99]
  - Map surface with tiles constructed according to all possible neighboring constraints
  - Inconsiste





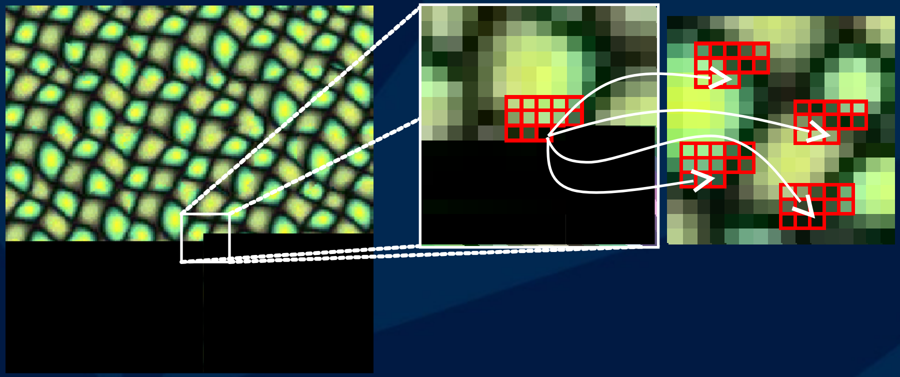
- Lapped textures [Praun, Finkelstein & Hoppe '00]
  - Paste pre-cut tiles on surface
  - Blend borders at rendering
  - Needs a specific rendering algorithm or extra texture storage



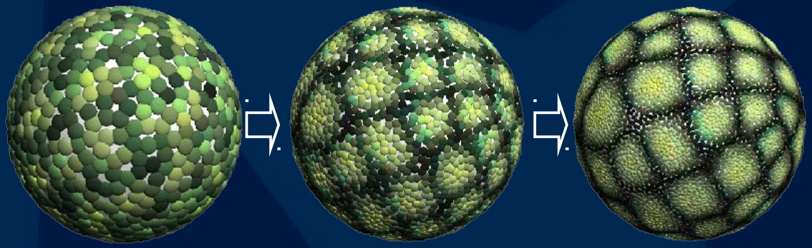


Previous works - On-mesh synthesis

- Non parametric sampling [Efros & Leung'99]
  - Use pixel coherence



- 3D Point-based synthesis [Turk'2001, Wei & levoy 2001]
  - Proceed hierarchically
  - Produces a collection of colored points in 3D
  - Needs a specific rendering algorithm or extra texture storage

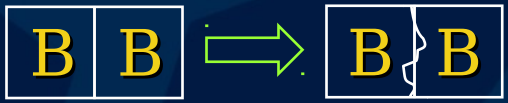


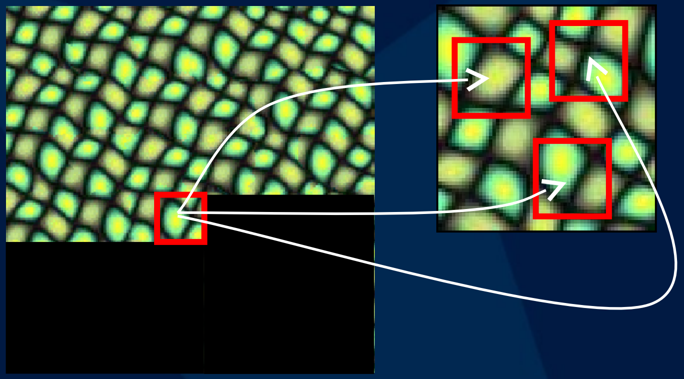
Previous works - Conclusion

- No 3D method provides at the same time
  - Initial mesh conservation
  - Initial texture sample conservation

⇨ This is what we would like to do

- Related work in 2D: [Efros & freeman 2001]
  - Paste blocks selected from texture sample
  - Reduce discontinuities

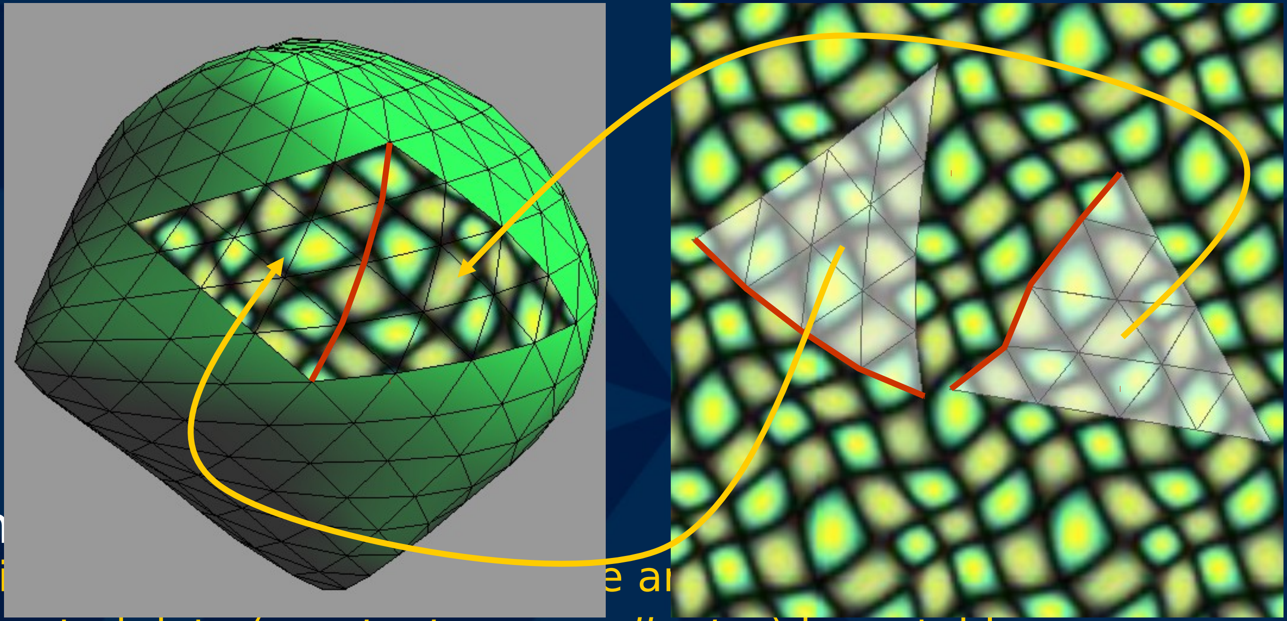




  - Is it possible on a mesh?

Proposed approach

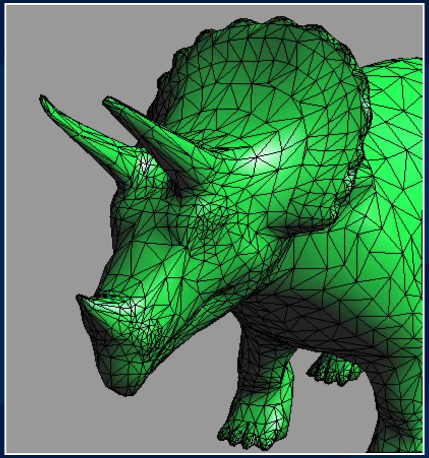
- Select independent regions in the texture that match once mapped on the mesh



- Advan
  - Origi e ar
  - Computed data (*e.g. texture coordinates*) is portable

Algorithm (and talk) overview

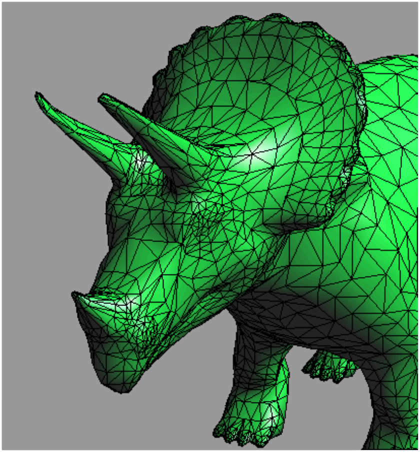
Texture sample - Mesh

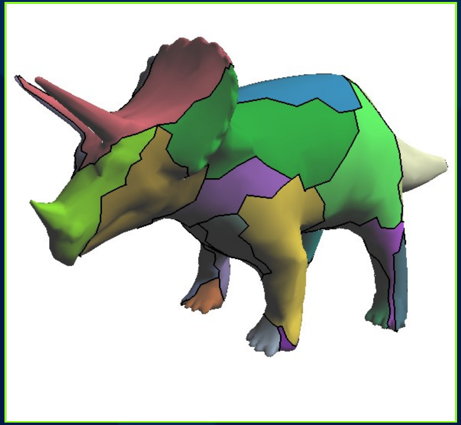


Algorithm (and talk) overview

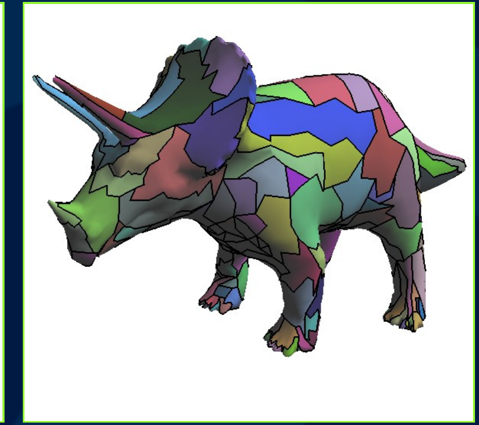
Texture sample - Mesh

Design a *face-cluster* hierarchy



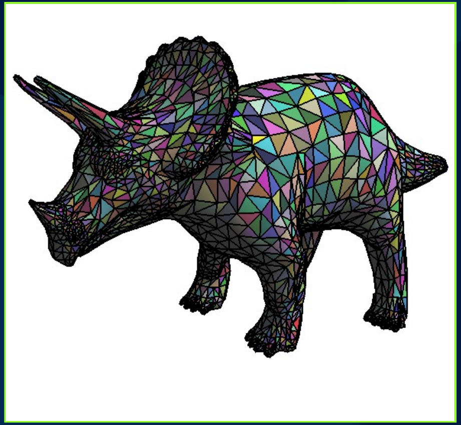


Level 0



Level 1

. . .



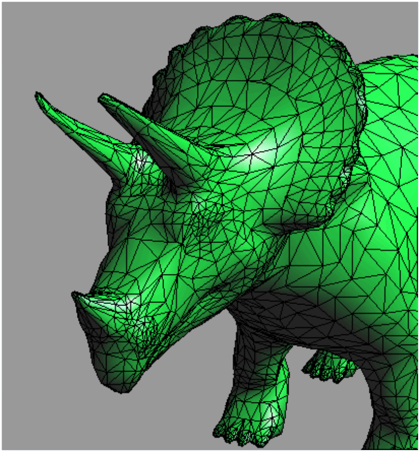
Deepest level

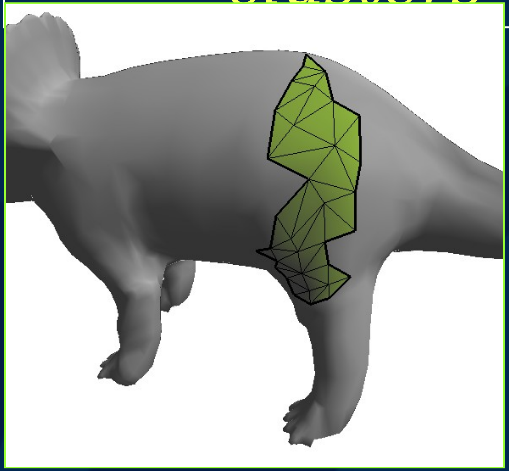
Algorithm (and talk) overview

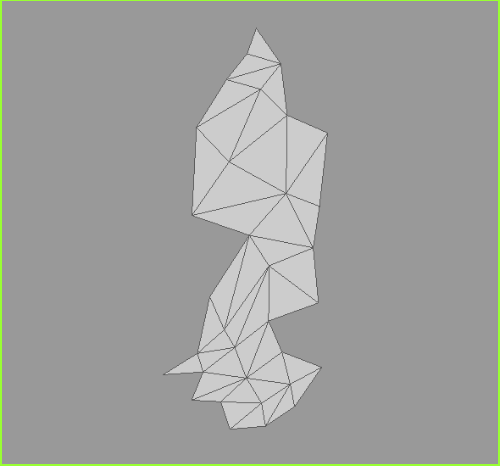
Texture sample - Mesh

Design a *face-cluster* hierarchy

Flatten *face-clusters*

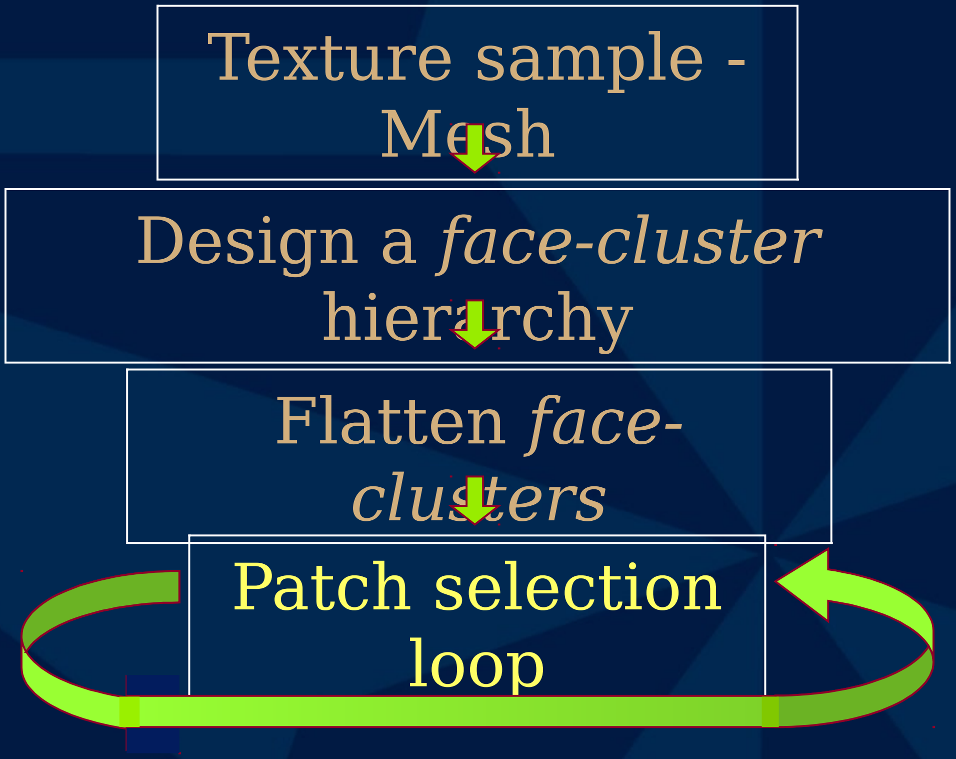






Texture space

Algorithm (and talk) overview

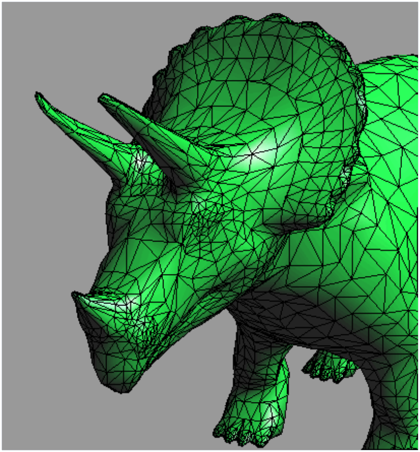


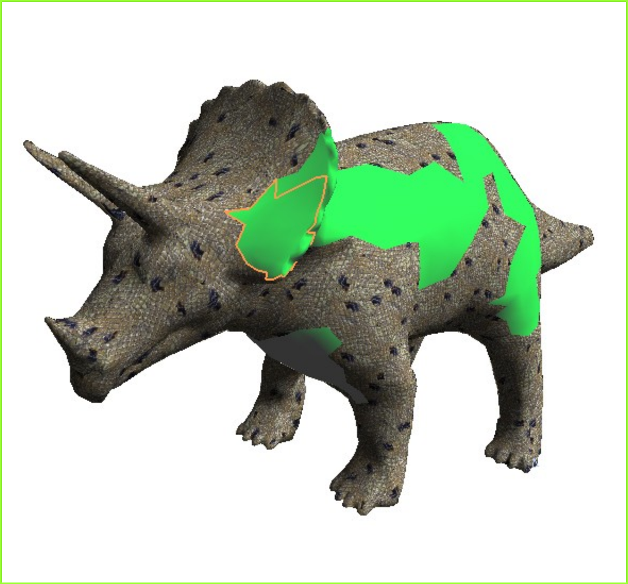
Texture sample - Mesh

Design a *face-cluster* hierarchy

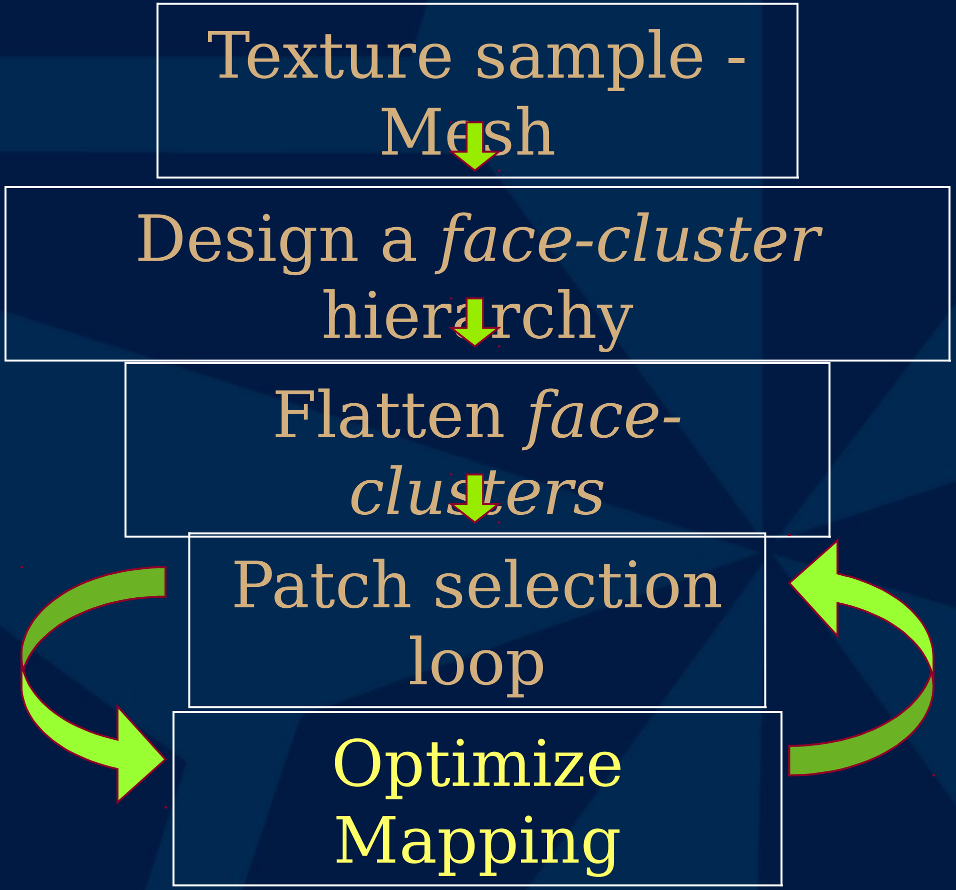
Flatten *face-clusters*

Patch selection loop





Algorithm (and talk) overview



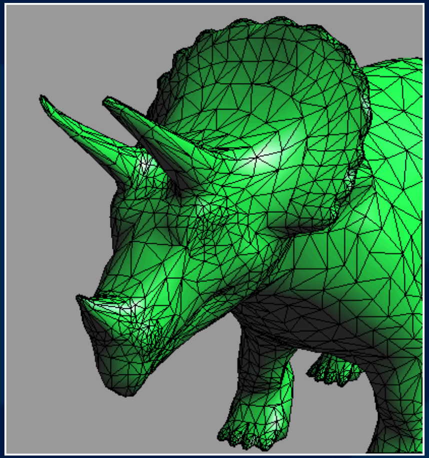
Texture sample - Mesh

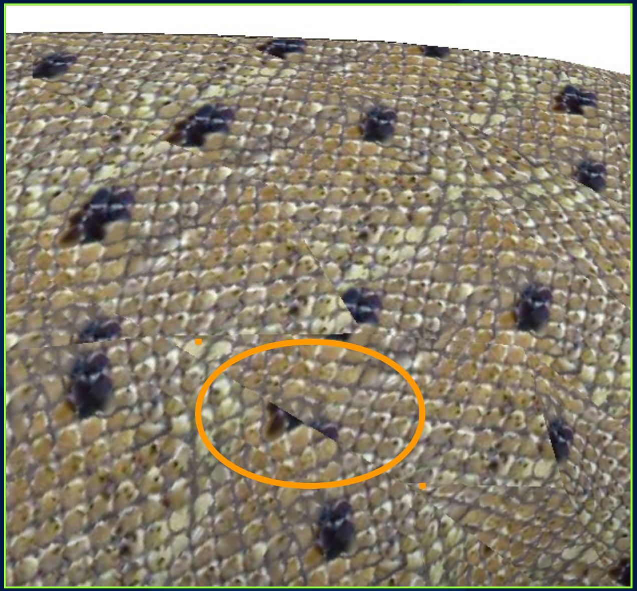
Design a *face-cluster* hierarchy

Flatten *face-clusters*

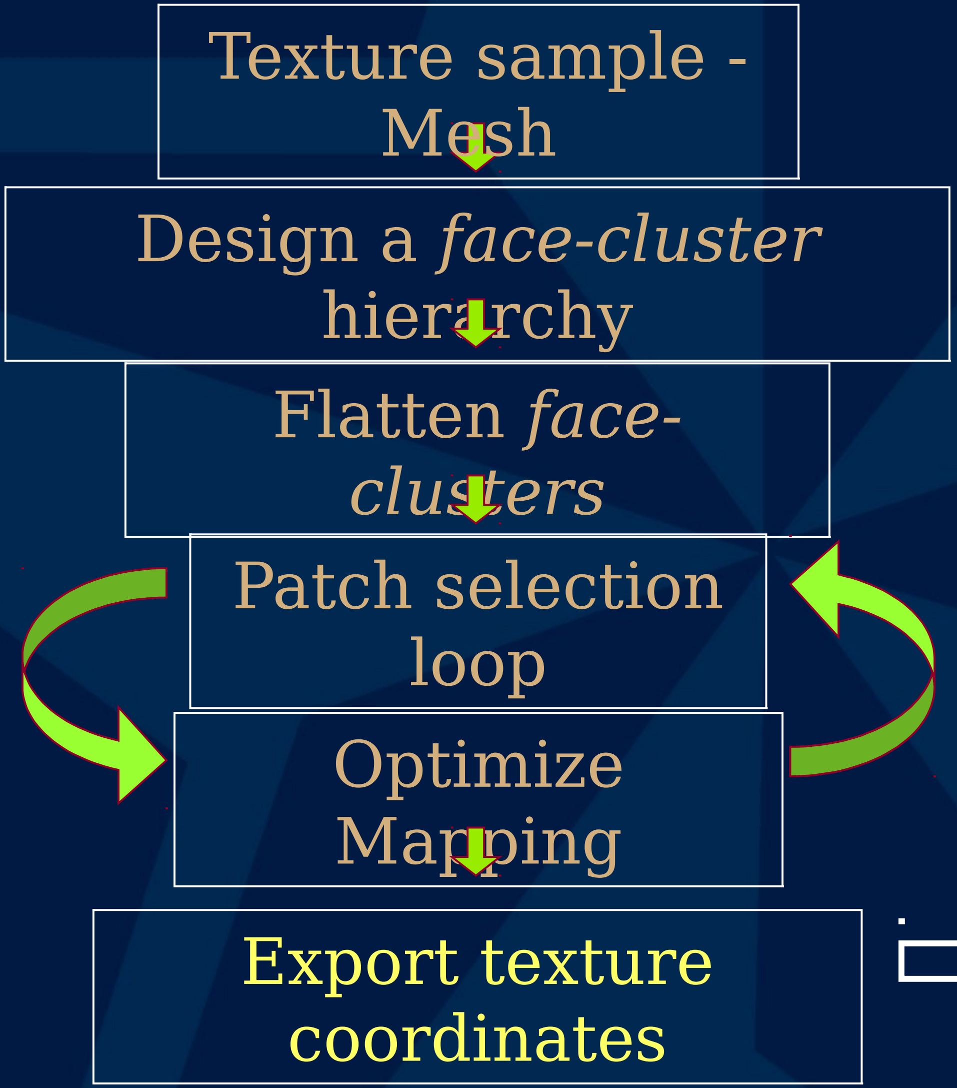
Patch selection loop

Optimize Mapping





Algorithm (and talk) overview



Texture sample - Mesh

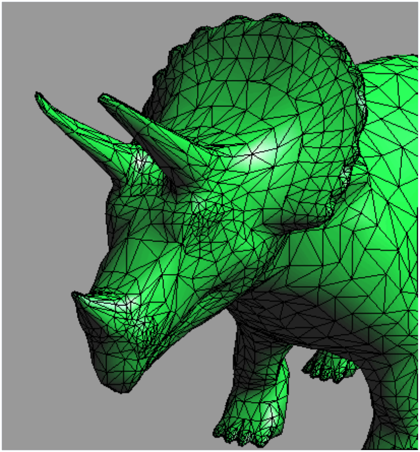
Design a *face-cluster* hierarchy

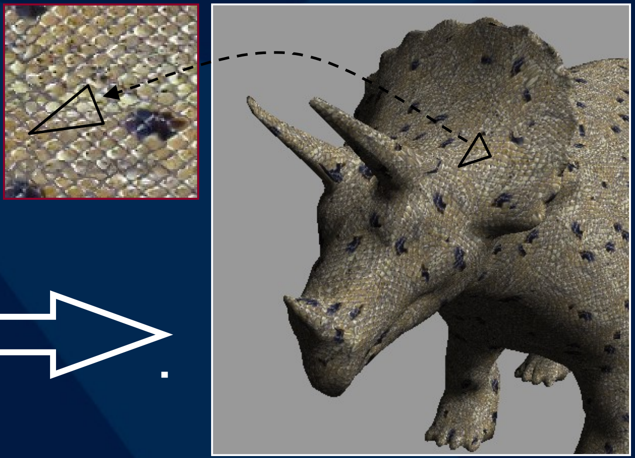
Flatten *face-clusters*

Patch selection loop

Optimize Mapping

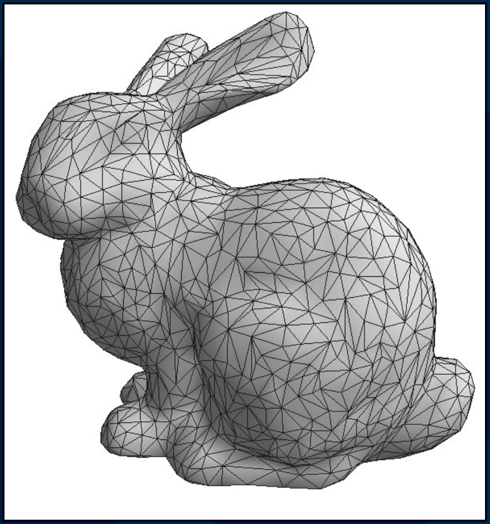
Export texture coordinates

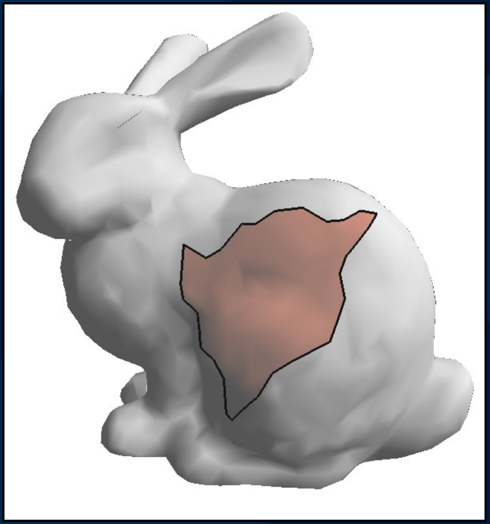


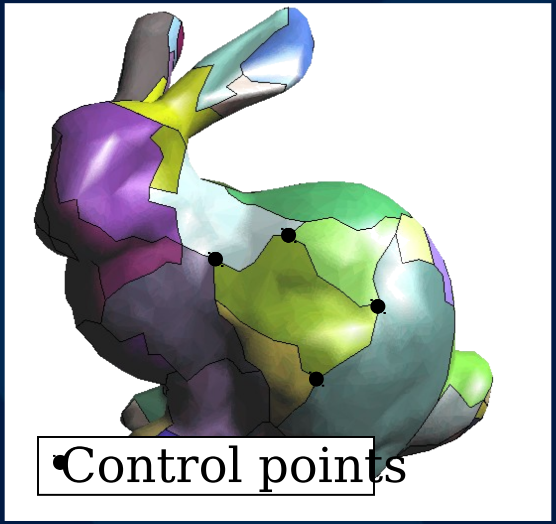


Design a *Face-Cluster* hierarchy

- Requirements:
  - Face-clusters should be able to project on a plane
- Simple subdivision method:
  - Start with *n* seed faces (randomly chosen)
  - Assign mesh faces to the sub-cluster of closest seed

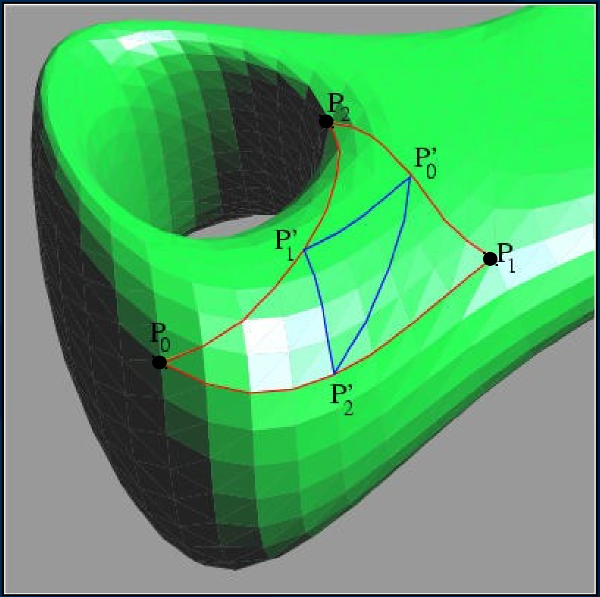




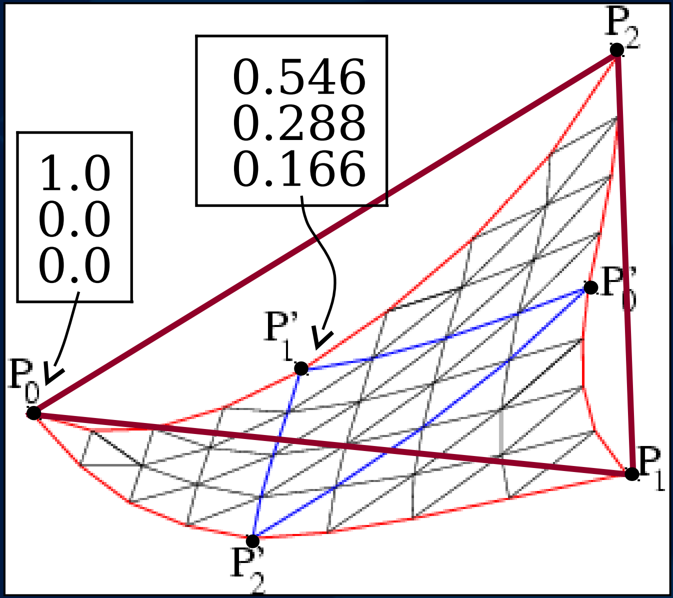


Flattening face-clusters

- For each face-cluster in texture space
  - Pre-compute relative position of control points w.r.t. parent control points in texture space
  - Use barycentric coordinates
  - Compute them with a heuristic



Surface space

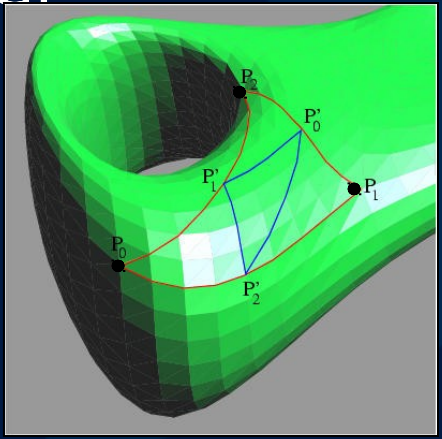


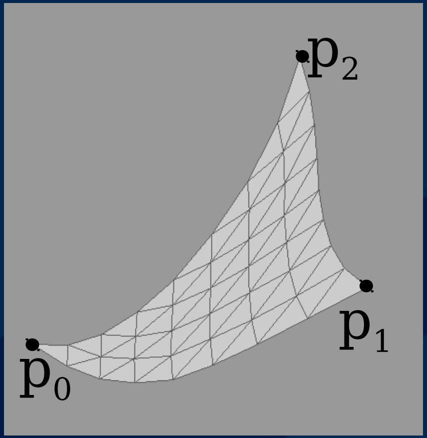
Texture space

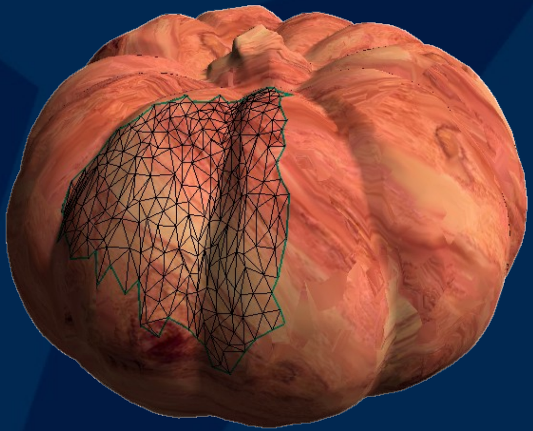
Flattening face-clusters

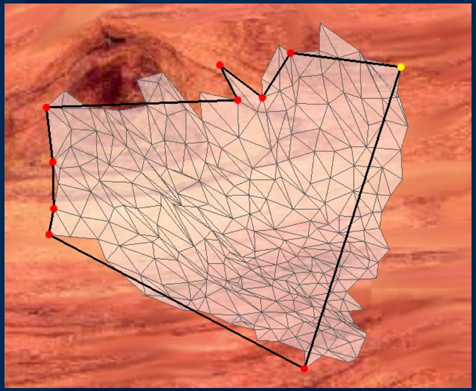
- To flatten a face-cluster
  - Position parent control points
  - Recursively compute point positions
- Advantage
  - Real-time update when control points move

⇨ Useful to optimize fitting

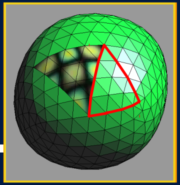








Face-cluster selection algorithm

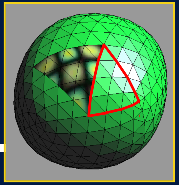


Select and texture face-clusters until total coverage

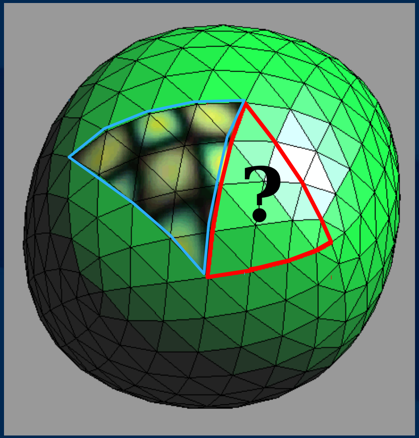
Rules:

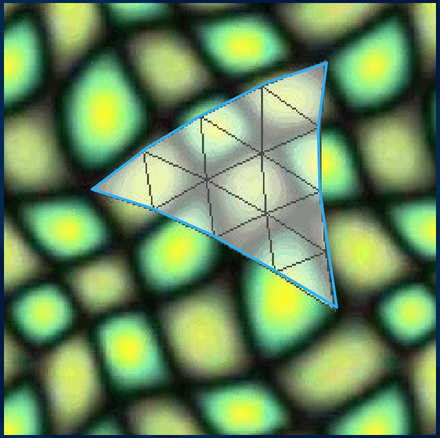
1. Select clusters at highest possible level
2. Propagate mapping to neighboring clusters
3. If too much error (flattening or fitting)
   Subdivide

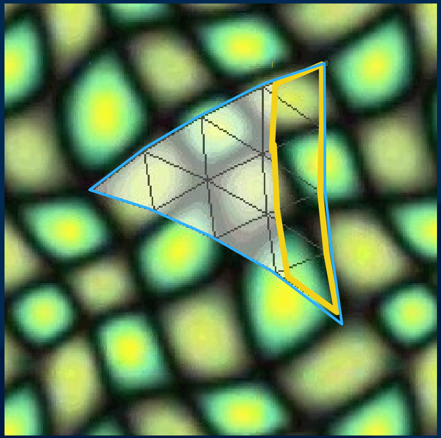
Texture patch fitting



- Extraction of a mask

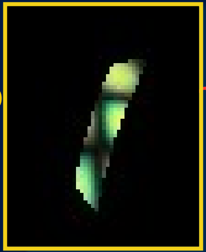


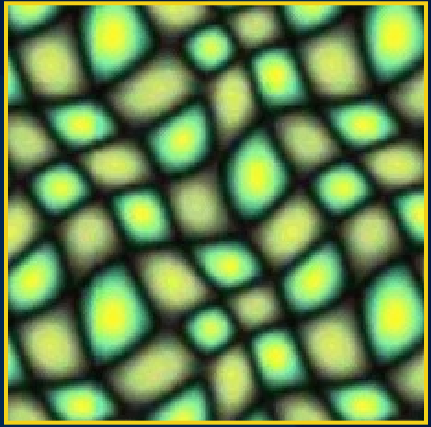




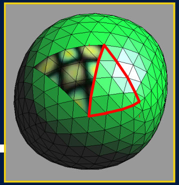
- Fitting
  - Can we find somewhere into ?

gives a possible positio neighbor

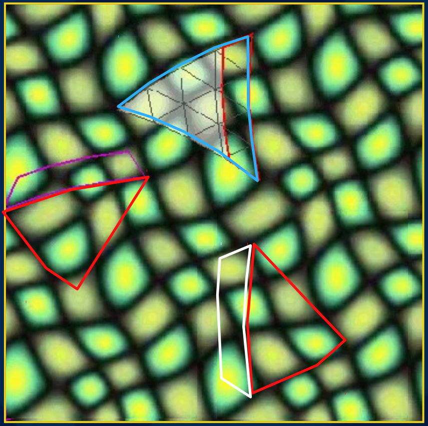




Texture patch fitting



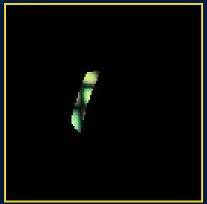
- Example solutions:



- Best match searching for a translation *x*
  - Minimize L_2 distance between *I* and *T* over *J*

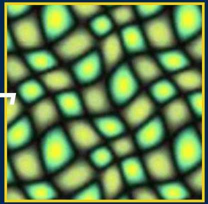
$$E(x) = \sum_{y} J(y)\,(I(y) - T(x+y))^2$$

I

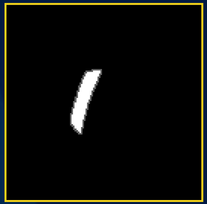


  - Direct computation is costly !!

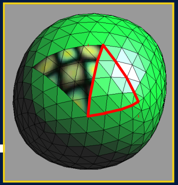
T



J



Texture patch fitting



- Express $E(x)$ g image correlation

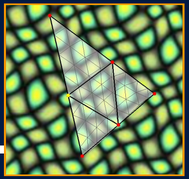
$$E(x) = \sum_{y} I(y)^2 + \left(-2\ I \diamond T + J \diamond (T^2)\right)(x)$$

- Compute correlation using FFT ( ) $\mathcal{F}$

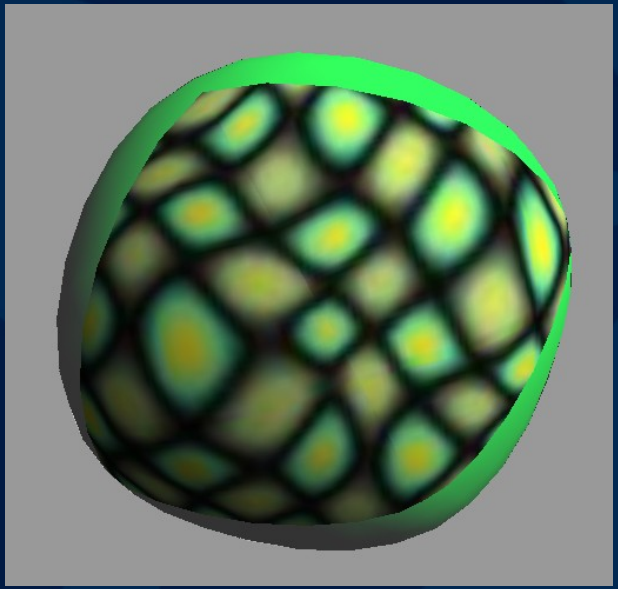
$$f \diamond g = \mathcal{F}^{-1}\left(\mathcal{F}(f)\overline{\mathcal{F}(g)}\right)$$

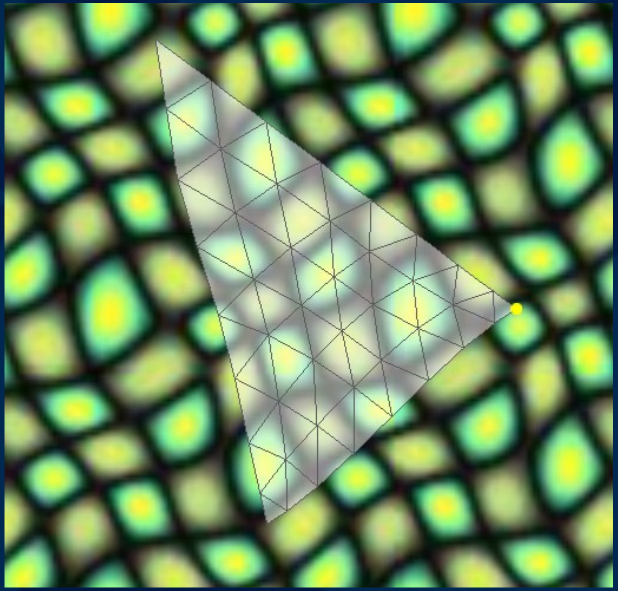
  - Only *F(I)* and *F(J)* must be re-computed at each search
  - *F(T)* and *F(T*^{2}*)* are computed once and saved.
- Pre-compute *F(T)*, *F(T*^{2}*)* for various orientations
- Sample topology is not necessarily toroidal

Mapping optimization

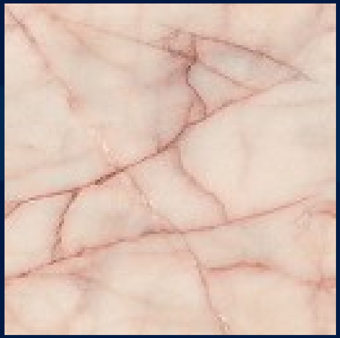


- For each newly mapped face cluster
  - Minimize discontinuity along edges with neighbors
  - Recursively moving control points

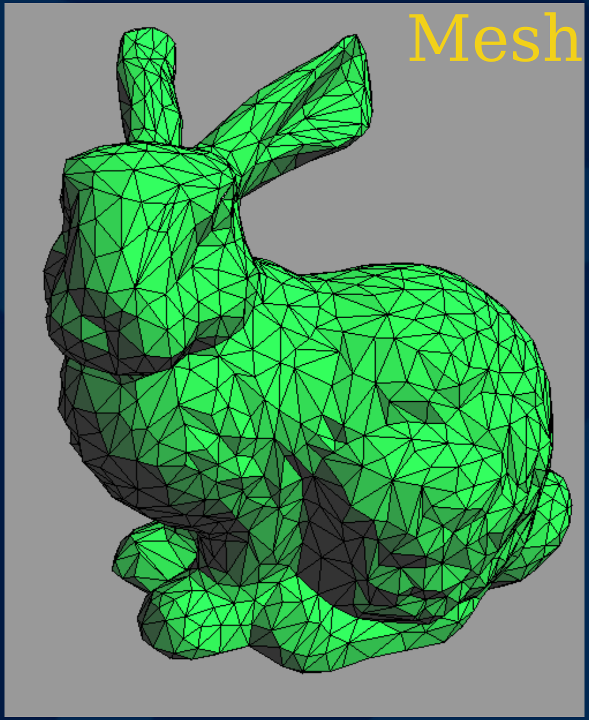




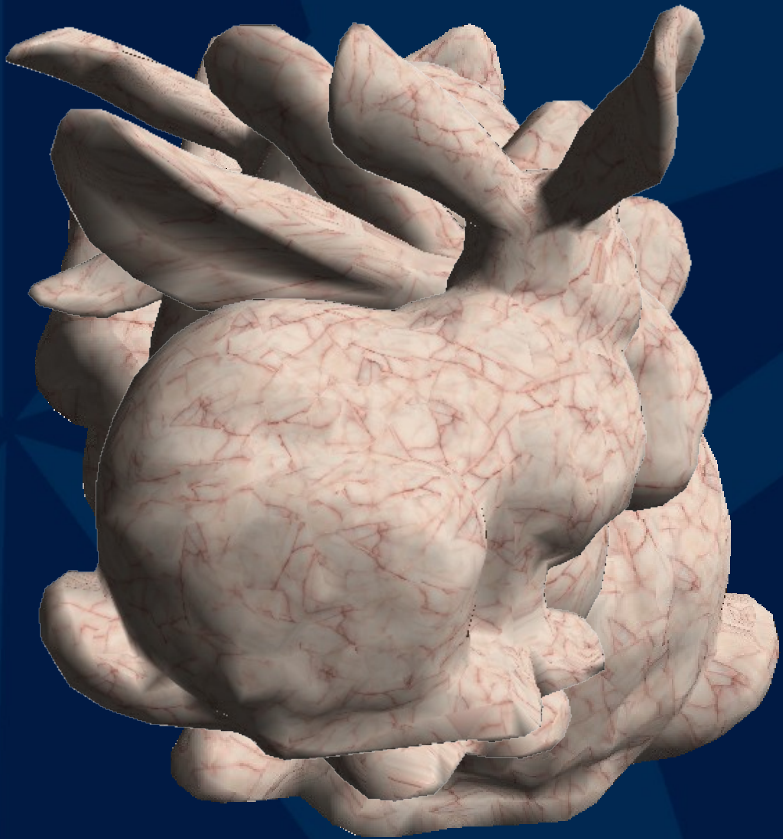
Results - (1) isotropic pattern



Sample



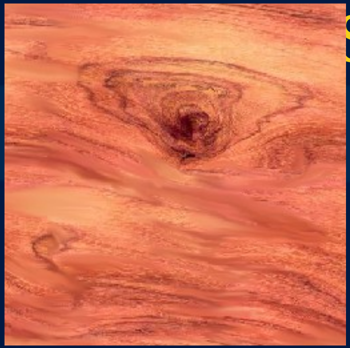
Mesh



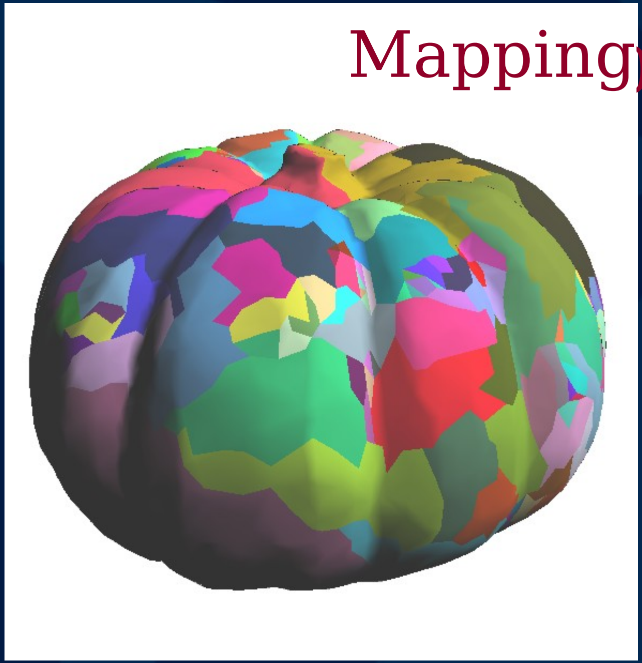
Result (Pentium I

2 mn

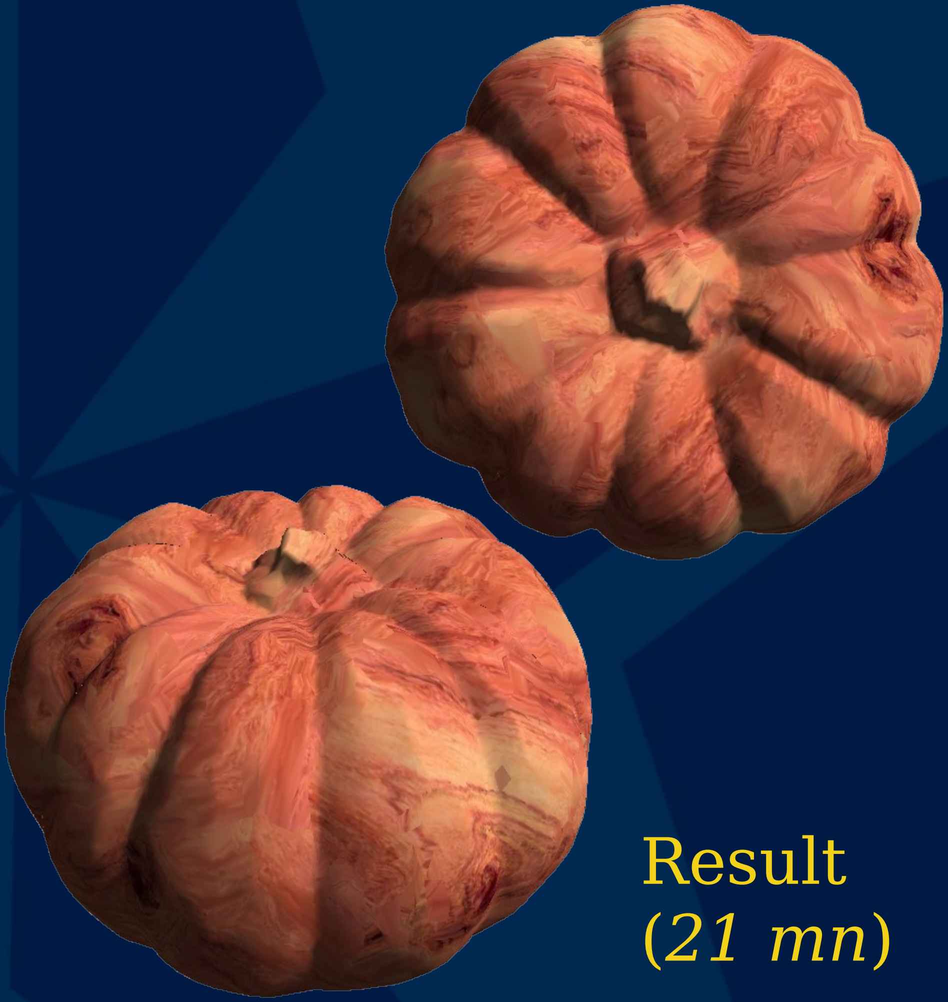
Results - (1) isotropic pattern



Sample

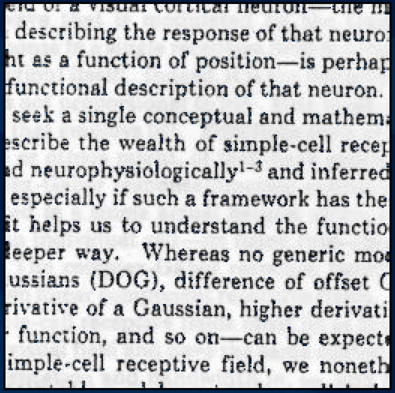


Mapping



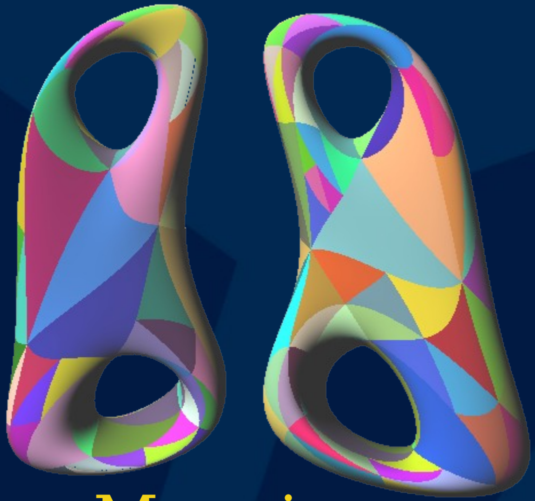
Result
(21 mn)

Results - (2) anisotropic pattern

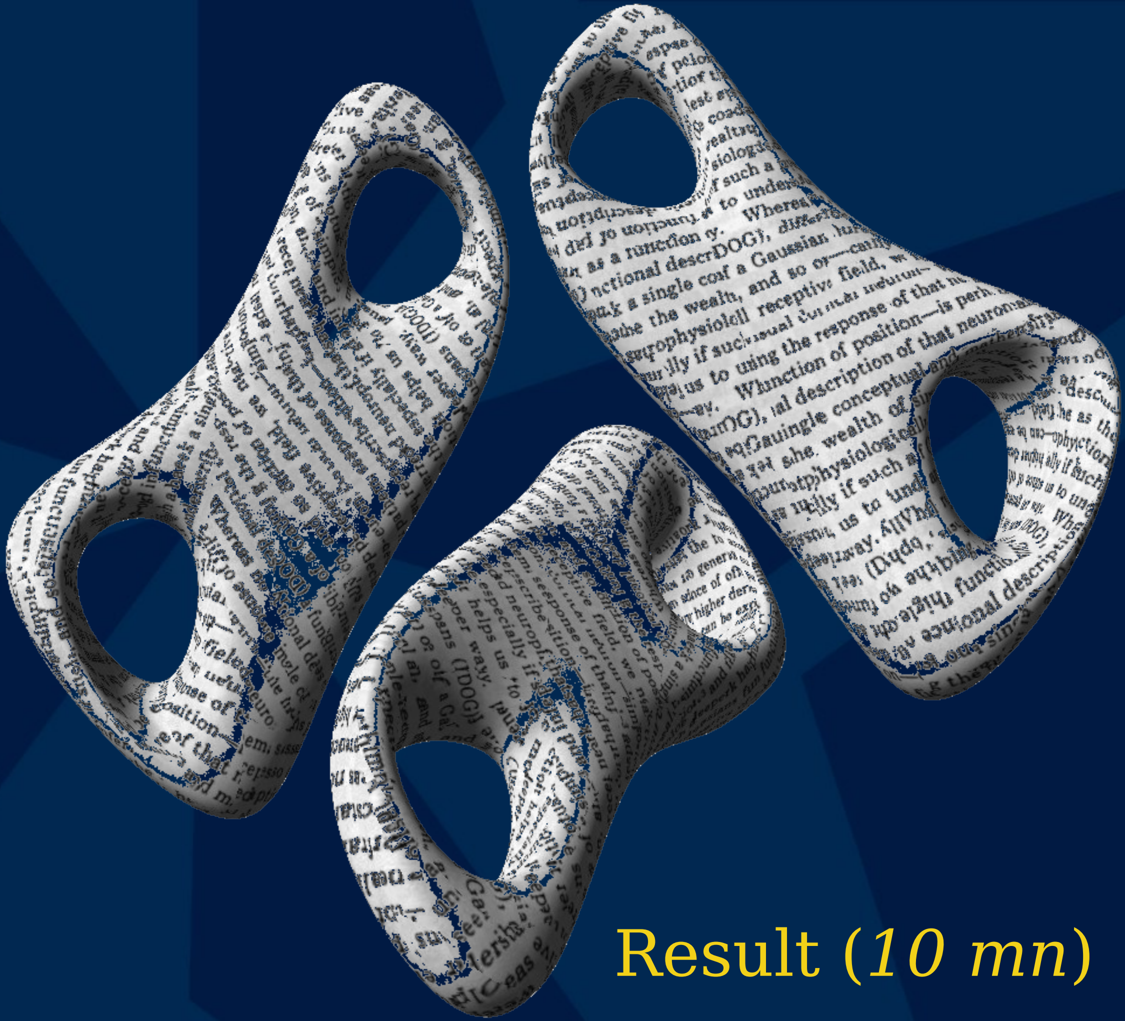


eld of a visual cortical neuron—the m
describing the response of that neuro
ht as a function of position—is perhap
functional description of that neuron.
seek a single conceptual and mathema
escribe the wealth of simple-cell recep
d neurophysiologically$^{1-3}$ and inferred
especially if such a framework has the
it helps us to understand the functio
leeper way. Whereas no generic mo
ussians (DOG), difference of offset C
rivative of a Gaussian, higher derivati
function, and so on—can be expecte
imple-cell receptive field, we noneth

Sample

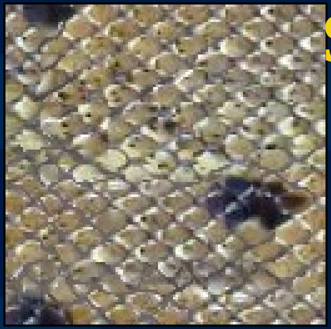


Mapping

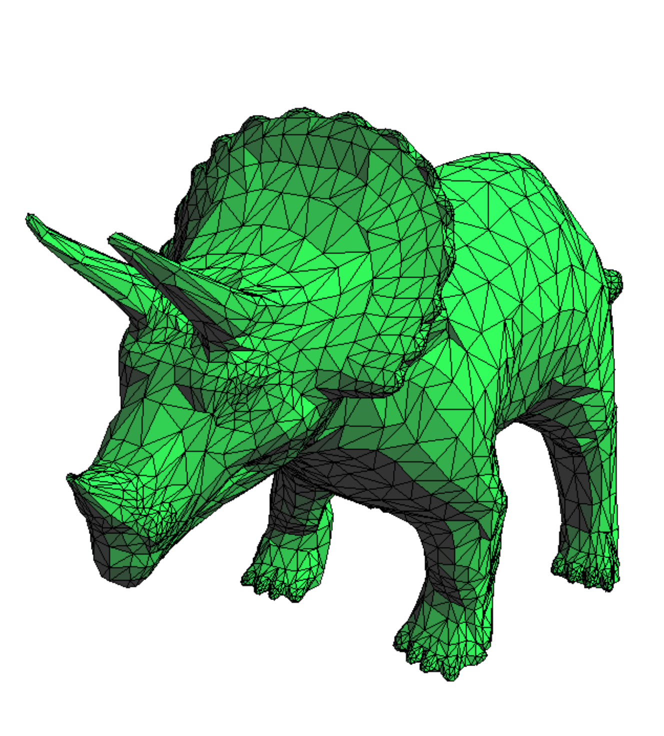


Result (*10 mn*)

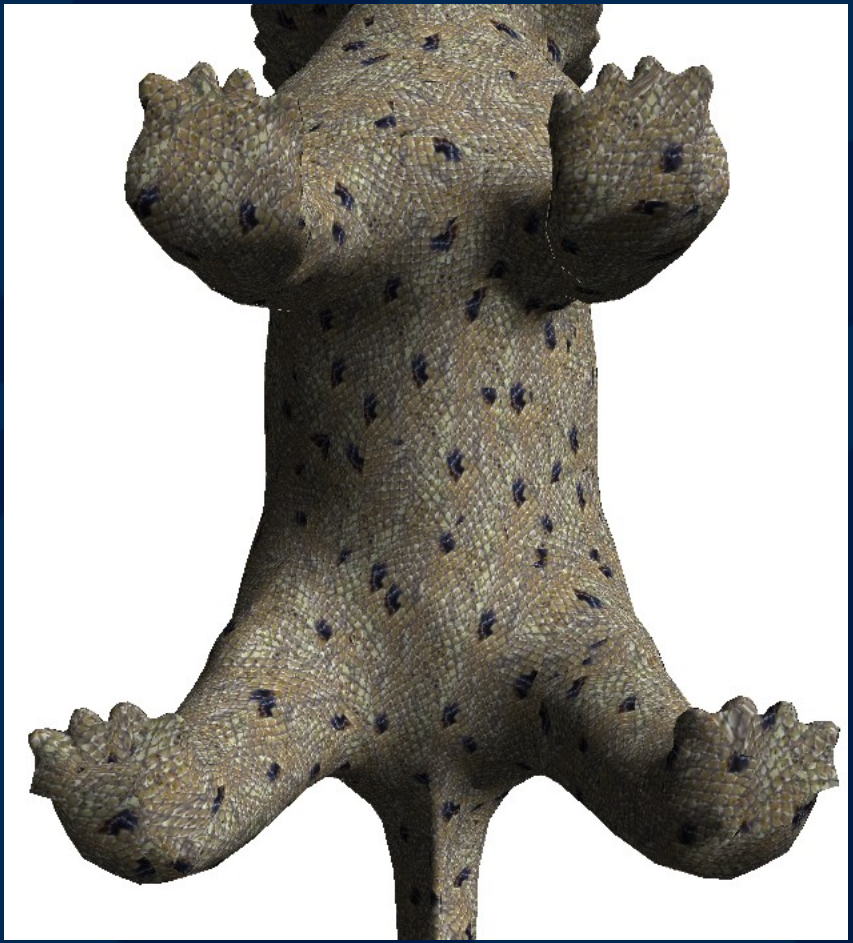
Results - (3) fun



Sample

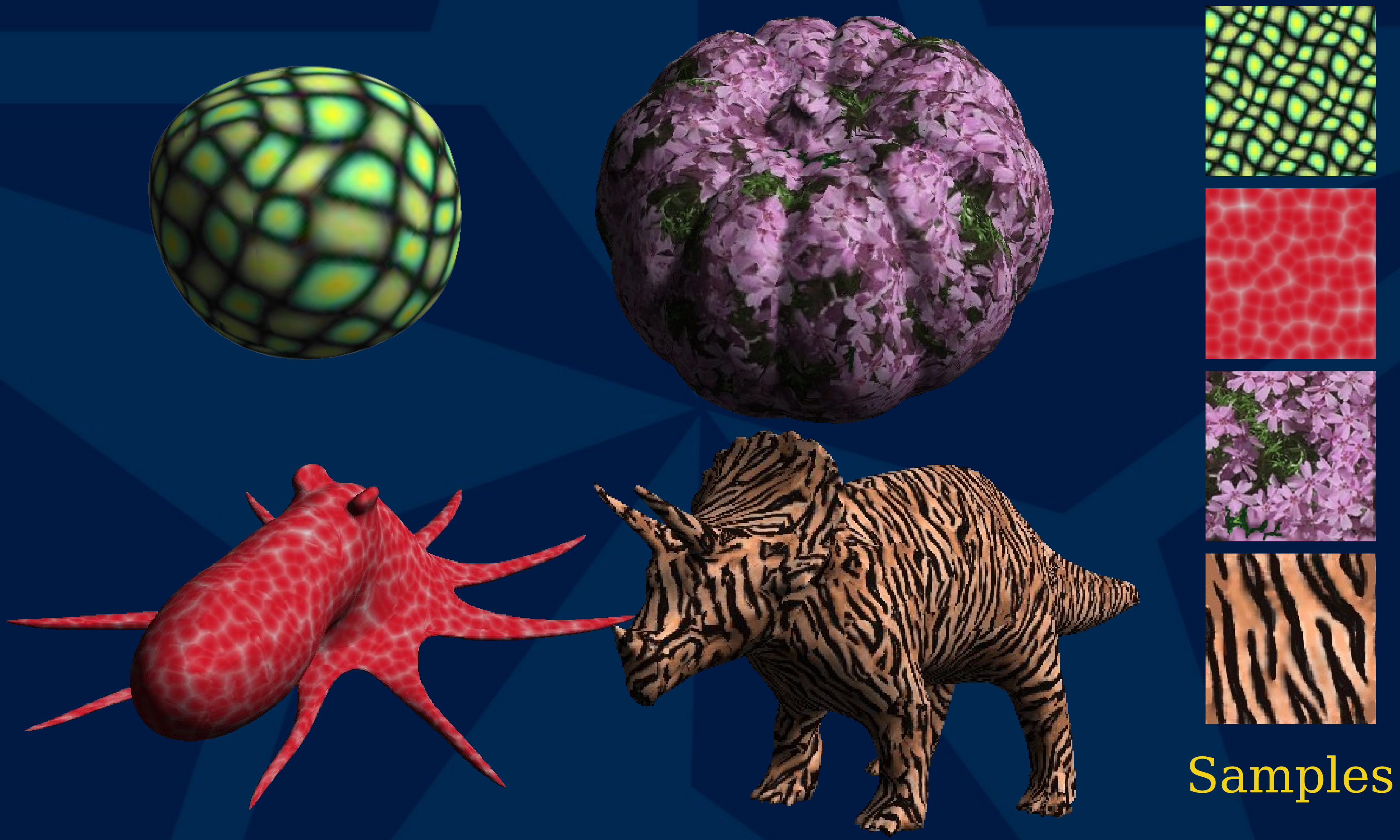


Mesh



Result (*29 mn*)

Results - (3) fun

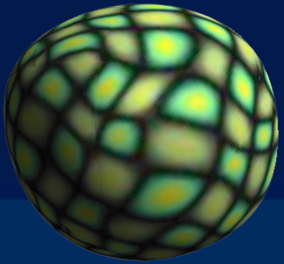


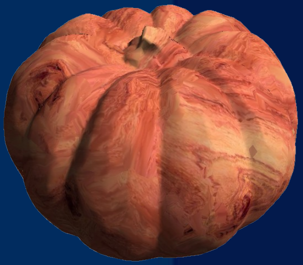
Conclusion - Future work

- Advantages
  - Preserves initial texture sample and mesh geometry
  - Exports texture coordinates only
- Limitations
  - Mesh resolution should be finer than texture features
  - The mapping is (almost) never perfect

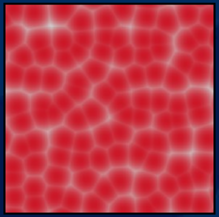
⇨ Still consistent with input mesh resolution
Trade-off: enable local mesh refinement

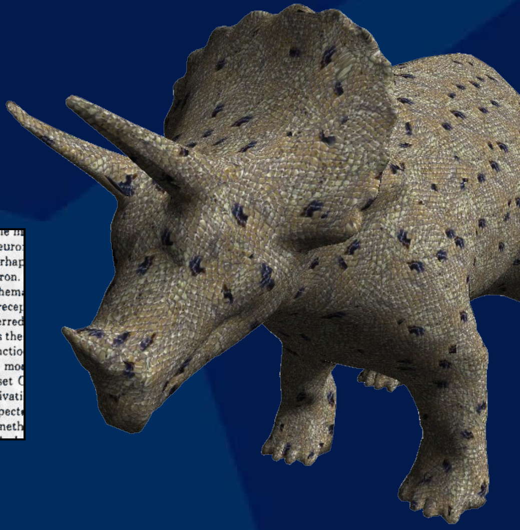
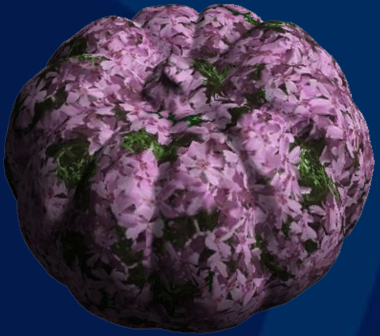
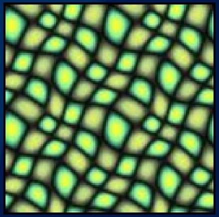
- Improvements
  - Allow human intervention during algorithm
  - A better clustering would increase speed

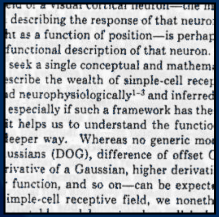




Thanks
for listening





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it helps us to understand the functio
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Design a *Face-Cluster* hierarchy

- Few requirements
  - Face-clusters should be able to project on a plane

⇨ no need for complex methods

- General meshes: simple subdivision method:
  - Start with *n* seed faces (randomly chosen)
  - Assign mesh faces to the sub-cluster of closest seed
- Subdivision surfaces: intrinsic subdivision